The combination of the CPU card featured elsewhere in this issue and the VDU card published in our September number, with the addition of a keyboard, a monitor, and the necessary software results in a universal terminal which is really inexpensive for its capabilities. The terminal has an RS 232 connection with VT 52 protocol and can therefore be coupled directly to any computer provided with such a connection. An example is the 16-bit Force II which, in conjunction with this terminal, gives an excellent cost/performance ratio.

universal terminal...

. . . linking the computer to the user

This universal terminal should not be thought of as just a replacement for the Elekterminal. Connecting the latter to a large computer gives immediate problems because it does not provide handshake lines. The present terminal, however, provided as it is with an RS 232 connection and VT 52 protocol, can be connected to a large computer without further ado. (The VT 52 protocol is a communication agreement extensively used in industrial terminal applications.) As the RS 232 is a serial connection, it is also possible, by means of a modem, to communicate with a so-called host computer anywhere in the world over a telephone line.

Moreover, this universal terminal, in contrast to the Elekterminal, provides an adjustable image format and graphics possibilities.

Construction

The general layout of the terminal is shown in figure 1. As can be seen, all constituent parts have already been described: in 'CPU card' elsewhere in this issue, and in 'VDU card' in the September issue. Basically, the construction consists of combining a CPU card and a VDU card by, for instance, the Elektor bus board, and connecting a monitor (or normal TV receiver) to the VDU card, and a keyboard to the CPU card. The required software for the system can be contained in a 2732 EPROM for which there is a convenient slot on the CPU card.

It is also possible to connect a printer with Centronics interface to the terminal. Furthermore, some preliminary work has been done towards a light-pen connection, but this option will have to wait until a future issue.

The CPU card is programmed by means of shorting plugs, for instance, as regards image format and memory index. The shorting-plug positions for these specific applications are given in table 1. The memory index will then look as shown in figure 2. The image format must, of course, be chosen in relation to whether a proper monitor or a TV set is used. If the latter, it is recommended that fewer characters per line are selected than with a monitor.

The address decoding of the 2 k RAM and 4 k EPROM used in the present project is also arranged by means of shorting plugs as

1

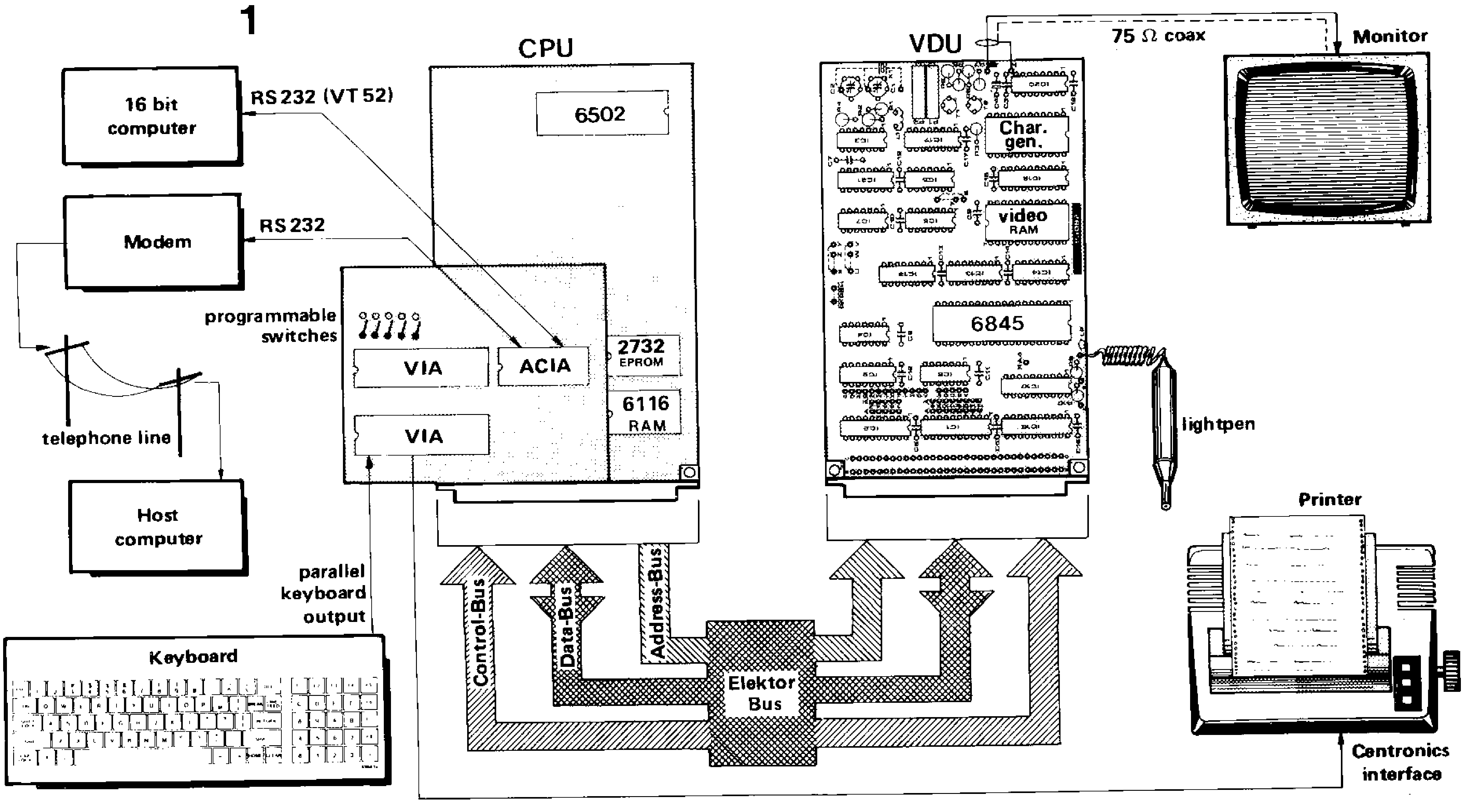

Figure 1. The layout of the universal terminal with all possible connections. Connecting a 16-bit computer (for instance, a Force II which is based on a 68000 CPU) yields, to the best of our knowledge, the cheapest 16-bit computer system available.

indicated in table 1.

Furthermore, a number of connections have to be made on the CPU card between the outputs of the address buffers and points A . . . J to obtain the chip-select signal for the various ICs. These connections should be made by short lengths of wire soldered to the appropriate connector-pins, according to the circuit diagram of the CPU card.

The programming of the ACIA (PL3 and PL4 on the CPU card) should be carried out with the aid of the manual of the computer used, and table 2 in the CPU card article.

Software for the terminal

Appropriate software is, of course, indispensable for the correct operation of the terminal. An associated program (ESS 525) is available from Technomatic Ltd. This program consists of the following parts:

- Console Command Processor, which ensures that the various commands are executed
- Video routines and sub-routines (cursor control, and so on) which are necessary for the proper operation of the VDU card
- Table of commands, which ensures that keyed-in commands are 'understood'
- Centronics output routine, which is necessary for printer control
- Image format table with which the preset image format is realized.

The Console Command Processor reads the keyboard and distinguishes between normal text and commands, a list of which is given in table 2.

A source-listing of the relevant program together with additional information (VDU Paperware) will become available through our book service in a few months' time. The additional information refers to the combination of the VDU card with the CPU board and to the CRT controller, the ACIA, and the character generator. ◾

2

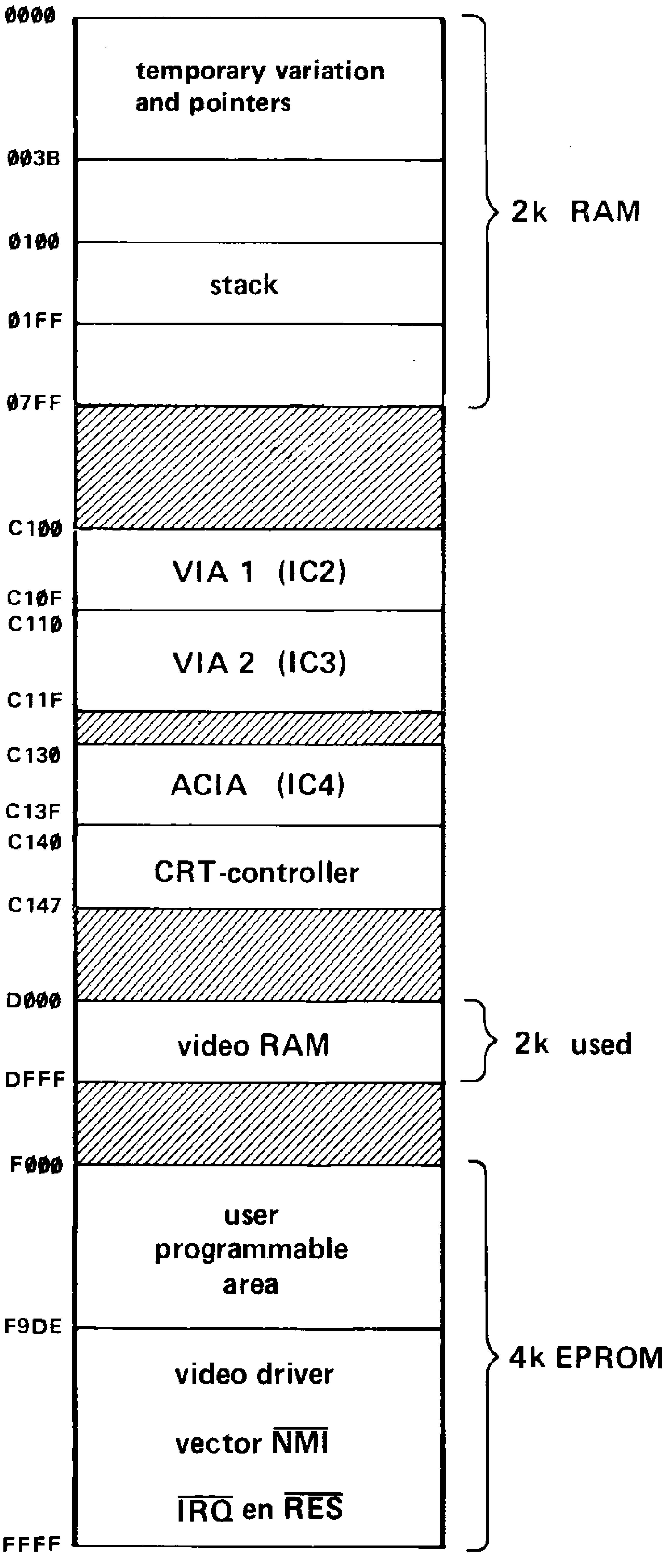

Figure 2. Summary of the memory index.

Table 1

connector	interconnection	function
PL6		image format setting:
	none	80 x 24
	5-6	80 x 25
	3-4	64 x 16
	3-4, 5-6	64 x 24
	1-2	90 x 22
	1-2, 5-6	48 x 12
	1-2, 3-4	24 x 24
	1-2, 3-4, 5-6	user programmable
PL9	3-4, 7-8, 11-12 15-16, 19-20	RAM address decoding
PL10	none	for addressing
PL13	1-2	0000-07FF
		EPROM address decoding
PL11	1-2, 5-6	for addressing
PL12	1-2, 7-8, 17-18	F000-FFFF

Table 1. This shows how the CPU card is programmed for this application by means of shorting plugs. Programming of the ACIA is carried out with the aid of the manual of the computer used and table 2 of the CPU card article in this issue.

Table 2

	code	keyed	command
VT 52	000D	(CR)	carriage return
	000A	(LF)	line feed
	0008	(BS), (CTRL-H)	back space
	1B48	(ESC) (H)	cursor home
	1B41	(ESC) (A)	cursor up
	1B42	(ESC) (B)	cursor down
	1B43	(ESC) (C)	cursor right
	1B44	(ESC) (D)	cursor left
	1B4B	(ESC) (K)	erase to end of line
	1B4A	(ESC) (J)	erase to end of screen
CP/M	000B	(CTRL-K)	cursor up
	000C	(CTRL-L)	cursor right
	0011	(CTRL-Q)	erase to end of screen
	0018	(CTRL-X)	erase to end of line
	001A	(CTRL-Z)	clear screen & home
	001E	(CTRL-^)	cursor home
	000A	(CTRL-J)	cursor down
	0010	(CTRL-P)	select/deselect centronics
	1B52	(ESC) (R)	delete line
	1B2A	(ESC) (x)	clear screen & home
	1B3A	(ESC) (:)	clear screen & home
	1B54	(ESC) (T)	erase to end of line
	1B74	(ESC) (t)	erase to end of line
	1B59	(ESC) (Y)	erase to end of screen
	1B79	(ESC) (y)	erase to end of screen
	0006	(CTRL-F)	select/deselect auto LF
	0002	(CTRL-B)	select/deselect half duplex

**Table 2. Commands for the cursor control and the erasing of (parts of) the screen.
(CTRL . . . means that a key is pressed *while* the control key is pressed and ESC . . . indicates the *successive* pressing of the escape key and another as shown.)**